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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/717,122	11/19/2003	Larry Zhao	2000.106900	7303

23720 7590 09/13/2007
WILLIAMS, MORGAN & AMERSON
10333 RICHMOND, SUITE 1100
HOUSTON, TX 77042

EXAMINER

GHYKA, ALEXANDER G

ART UNIT	PAPER NUMBER
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2812

MAIL DATE	DELIVERY MODE
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09/13/2007

PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary

Application No.

10/717,122

Applicant(s)

ZHAO ET AL.

Examiner

Alexander G. Ghyska

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 20 June 2007.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 39-56 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 39-56 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

ALEXANDER GHYKA
PRIMARY EXAMINER

AU 2812
Alex Ghyska

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 19 November 2003 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO/SB/08)
Paper No(s)/Mail Date _____
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date _____
- 5) ☐ Notice of Informal Patent Application
- 6) ☐ Other: _____

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DETAILED ACTION

Applicants' response of 6/27/2007 has been considered and entered in the record. Claims 39-56 are under consideration. The following new rejection is made in view of Applicants' amendments. Applicants' arguments are moot in view of the new grounds of rejection.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claims 39-56 are rejected under 35 U.S.C. 103(a) as being unpatentable over Besser et al (WO 03/007368).

The present claims generally require a method of forming a silicon and nitrogen containing dielectric layer comprising a first sub-layer containing silicon and nitrogen, a second sub-layer containing silicon and nitrogen, and an intermediate sub-layer containing silicon and nitrogen positioned between said first and second sub-layers, the method comprising providing a structure comprising an exposed copper surface; and performing at least one deposition process to form said first, second and intermediate sub-layers above said exposed copper surface, said first sub-layer having a first surface that interfaces with said exposed copper surface, said intermediate layer having a surface that interfaces with said first sub-layer, said second sub-layer having a first surface that interfaces with said intermediate layer and a second surface that is opposite said first surface of said second sub-layer, wherein the parameters of said at least one deposition process are adjusted such that a concentration of silicon in said first sub-layer is less than a concentration of silicon in said second sub-layer.

Besser et al disclose that the electromigration resistance of nitride capped Cu is improved by controlling the silicon nitride deposition. See the Abstract. Besser et al disclose introducing a wafer containing copper into a chamber; treating the exposed surface of Cu with a plasma containing ammonia or nitrogen; introducing silane until a flow rate of about 70 to about 90 sccm is achieved (which would constitute a first sub-layer comprising silicon and nitrogen), typically in about 2 to 5 seconds, followed by a stage during which the silane flow rate is increased to about 130 to about 170 sccm over a period of about 3 seconds to about 8 seconds, to form a silicon nitride layer by

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plasma enhanced chemical vapor deposition (which could be considered a second sublayer at the afore mentioned flow rate). See page 4, lines 20-30. Besser et al does not disclose interruption of the plasma, as required by present Claims 40, 45 and 48-53. Moreover, Besser et al discloses two separate sets of deposition parameters and a single silicon nitride layer, as required by present Claims 41, 42, 43 and 54-56. See page 4, lines 20-30.

Besser et al differs from the present claims in that it does not disclose an intermediate region, that the concentration of silane in the silicon nitride layer gradually increases from the first surface to the second surface, and the specific stoichiometric ratios as required by some of the dependent Claims.

It would have been obvious for one of ordinary skill in the art, at the time of the invention, that as the silicon precursor silane is gradually increased as disclosed by Besser et al, the concentration of the silicon would gradually increase. One of ordinary skill in the art would find it obvious that the increase of the silicon containing reactant, silane, would result in increased amounts of silicon in the silicon nitride layer formed by Besser et al. Furthermore, even though Besser et al does not explicitly disclose the formation of an intermediate sublayer, it would be obvious to one of ordinary skill in the art that the formed silicon nitride section formed while the silane flow is increased would have different properties (its gradually increasing silicon concentration) and would be considered an intermediate region. Moreover, as required by some of the claims, the concentration of silicon during the first sublayer (flowrate of 70 to 90 sccm) would be

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constant, it would rise during the transitional phase (the intermediate layer), and then it would be constant in the second sub layer (flowrate of 130 to 170 sccm).

Claims 44, 47 and 54-56 further require a deposition process for forming a nitride layer comprising a stoichiometric ratio of silicon to nitrogen at said first surface of said first sub-layer is within the range of approximately 0.2 to 0.45; and the stoichiometric ratio of silicon to nitrogen at said second surface of said second sub layer is within the range of approximately 0.45-0.8.

It would have been obvious to one of ordinary skill in the art, at the time of the invention, to arrive at the flow rates as required by the present claims, as Besser et al disclose the same process, silicon nitride formation, using the same reactants, silane and nitrogen, and the use of optimum stoichiometric ratios would be within the level of one of ordinary skill in the art. Where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation. See *Allen et al v. Coe*, 57 USPQ 136. Moreover, the discovery of an optimum variable in a known process is ordinarily within the skill in the art. See *In re Antonie*, 195 USPQ 6, (CCPA 1977); *In re Aller* 105 USPQ 233 (1955). In the present case the determination of the optimum stoichiometric ratios would be a matter of optimization for one of ordinary skill in the art for its benefit in optimizing the properties of the silicon nitride, and therefore a *prima facie* case of obviousness is established

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Alexander G. Ghyka whose telephone number is (571) 272-1669. The examiner can normally be reached on Monday through Friday during general business hours.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael Lebentritt can be reached on (571) 272-1873. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

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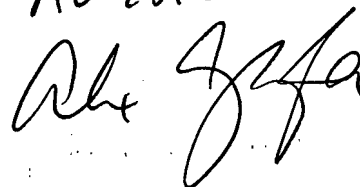
Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

AGG

August 30, 2007

ALEXANDER GHYKA
PRIMARY EXAMINER

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A handwritten signature in black ink, appearing to read 'Alex Ghyska', written over the printed name of the examiner.